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ABSTRACT

This paper examines the sensitivity of investment to cash flow using a panel of UK firms in manufacturing with a view to shedding some light on the existence of a balance sheet channel or financial accelerator. In addition to examining the impact of cash flow in different subsamples based on company size or financial policy (dividend payouts, share issues and debt accumulation), we also investigate the extent to which investment becomes more sensitive to cash flow in periods of monetary tightness. To this end, we employ a monetary tightness indicator constructed for the UK using the narrative approach pioneered by Romer and Romer. The results provide some support for the view that UK firms show greater investment sensitivity to cash flow during periods of tight monetary policy.

Keywords: financial constraints, balance sheet channel, investment.
JEL Classification: E22, E52, E44

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1. Introduction

The possible existence of a balance sheet channel as an additional mechanism through which monetary policy can be transmitted has received a lot of attention in recent years following the seminal work by Bernanke and Gertler (1989) on the propagation mechanism for real shocks. They argued that the existence of information asymmetries implies that a firm's (or household's) net worth is likely to influence investment (and more generally spending) decisions. The implications are profound. First, since net worth tends to be pro-cyclical, this will cause investment to move pro-cyclically thus generating accelerator effects and magnifying the amplitude of economic cycles. Second, shocks to net worth which are independent of output can cause fluctuations. A subsidiary consequence of this is that even small monetary policy shocks could have large effects.

Surprisingly, the majority of empirical papers in this area refer to the US, although the presence of financial constraints on firm investment policy is well-established for countries such as the UK[1]. It is the purpose of this paper to investigate the relationship between firm financial constraints and monetary policy for the UK, using a panel of UK firms in manufacturing over the period 1970 to 1991. In addition to examining the impact of cash flow in different subsamples based on company size or financial policy (dividend payouts, share issues or debt accumulation), we also investigate the extent to which investment becomes more sensitive to cash flow in periods of monetary tightness. To this end, we employ a monetary tightness indicator constructed for the UK using the narrative approach pioneered by Romer and Romer (1989).

The results provide some support for the view that, using firm size and firm financial policy to classify companies, potentially financially-constrained UK firms show greater investment sensitivity to cash flow. Firms as a whole also show greater sensitivity during periods of tight monetary policy and the effect is greater on those that are potentially financially-constrained. These results point to the possible existence of a balance sheet channel in addition to other possible transmission mechanisms such as interest rates, the exchange rate or a bank lending channel.

[1] See, for example, the survey by Schianterelli (1995). We discuss individual papers below in section 2.

The remainder of the paper is organized as follows. In the following section, we review some of the vast literature in this area, focusing, in particular, on papers that explore the hypotheses by examining investment behaviour using firm-level data. In section 3 we discuss data issues including the construction of our dummy variable representing periods of monetary tightening. Section 4 presents our results and some robustness tests and, finally, section 5 concludes.

2. Firm investment, the financial accelerator and the balance sheet channel of the monetary policy transmission

For more than two decades now, a large strand of the empirical work on investment in fixed capital has focused on the estimation of *q* models (Lucas, 1967; Gould, 1968; Uzawa, 1969; Treadway, 1969). One of the attractions of these models is that *q*, the shadow value of the firm if the capital accumulation constraint is relaxed, summarizes a firm's investment opportunities and determines its investment rate under the assumption that internal and external funds are perfectly substitutable (Modigliani and Miller, 1958). Empirical estimation of *q* models relies on Hayashi (1982) who showed that the unobservable marginal *q* is under certain assumptions equal to average *Q*[2], i.e. the market value of the firm divided by the replacement cost of installed capital. Average *Q* can be constructed from stock market data and hence an investment model based on average *Q* can be estimated[3].

However, two results in the empirical literature cast doubt on the sufficiency of *Q* as a theory of investment: low coefficients on *Q*, implying unreasonably high adjustment costs, and the statistical significance in investment regression of variables representing firm financial policy (such as cash flow). Low coefficients on Q are attributed primarily to measurement errors in *Q* and can be addressed by the use of appropriate estimation methods (IV). The apparent sensitivity of investment to cash flow has elicited a greater variety of interpretations.

An important suggestion is that cash flow is closely correlated with profits and sales and hence it helps predict future profitability, especially in the case of firms with

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[2] The assumptions are: perfect competition in the product market and linear homogeneity of the production and adjustment cost functions.

[3] For an alternative approach to estimating marginal *q* on the basis of a VAR model, see Abel and Blanchard (1986). Their results confirm the main findings of the average *Q* empirical literature.

monopoly power (Schiantarelli and Georgoutsos, 1990). In the event that marginal q and average Q are not equal, cash flow might simply act to correct that mis-measurement.

An alternative explanation is that managers use free cash flow (that is, cash flow that remains after investment in positive net present value projects) to overinvest, in which case the *Q* model, with its underlying assumption of profit maximizing firms, is not an appropriate description of firm investment behaviour (Jensen, 1986).

The third and most influential interpretation in the literature is that the significance of cash flow terms in investment regressions reflects the existence of financial market imperfections and provides support for the financial hierarchy model (Fazzari, Hubbard and Petersen, 1987; Cummings, Hassett and Hubbard, 1994; Bond and Mehir, 1994; Bond, Elston, Mairesse and Mulkay, 1997). Under asymmetric information between borrowers and lenders the perfect substitutability between internal and external funds collapses. External finance becomes more costly as it incorporates agency costs incurred by lenders for the monitoring of prospective borrowers. The wedge between the cost of external and internal finance is the external finance premium, which depends on the firm's financial health[4]. According to this argument, cash flow as a proxy for the firm's net worth determines the external finance premium facing the firm and hence the availability of funds for investment.

Given the existence of these theories with observationally equivalent implications with respect to coefficient on cash flow in investment equations, empirical support for the finance hierarchy theory requires the identification of a positive and significant effect from cash flow in firms that are likely to be constrained[5]. The firm characteristics which are used to split the sample into constrained and unconstrained firms include size (Audretsch and Elston, 1994), age (Chirinko and Schaller, 1995), dividend policy or retentions (Fazzari, Hubbard and Petersen, 1988; Gertler and Hubbard, 1988; Hubbard, Kashyap and Whited, 1995),

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[4] Of course, firms could face financial constraints that take the form of credit rationing. Gallegati (2001) and Almeida and Campello (2002) discuss the implications.

[5] It should be noted that this approach has not been without its critiques. Kaplan and Zingales (1997) disputed Fazzari, Hubbard and Petersen's (1987) results by questioning the relationship between the cash flow sensitivity of investment and the degree of financial constraints. This has sparked a lively debate with Fazzari, Hubbard and Petersen replying in 2000. Almeida and Campello (2002) argue that they uncover a precise relationship between cash flow sensitivity and financial constraints but that it suggests that cash flow sensitivity rises as firms become less constrained before falling to zero when firms are completely unconstrained.

close links with financial intermediaries (Hoshi, Kashyap and Scharfstein, 1991), issuance of public debt or access to bond markets (Gilchrist and Himmelberg, 1995; Kashyap, Lamont and Stein, 1994), coverage or leverage rations (Guariglia, 1999) and different financial systems (Bond, Harloff and van Reenen, 2003).

If financial market imperfections have important consequences for firm investment, their impact on the macro economy and the transmission of monetary policy is just as great. The financial accelerator is a mechanism through which small initial shocks can account for big fluctuations in output (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1995; Bernanke, Gertler and Gilchrist, 1996; Bernanke, Gertler and Gilchrist, 1998). This mechanism is set in motion by the presence of financial constraints and relies on a dual effect: an initial adverse shock squeezes firms' or households' cash-flows thereby increasing their need for external finance and, at the same time, the deterioration of their financial position makes it more difficult and more costly for them to raise external funds.

The financial accelerator provides the background against which the literature on the balance sheet channel of monetary policy transmission developed. A tightening of monetary policy reduces the value of (prospective) borrowers' collateral, while its effect on aggregate activity also reduces their cash flow. This in turn will lead to a propagation of the initial shock and larger effects on aggregate economic activity.

Whilst the balance sheet channel has been studied in several theoretical frameworks[6], of more interest to us here is the extensive empirical work that now exists. Bernanke and Gertler (1995) use macroeconomic time series data and a VAR model to examine the response of the economy to a monetary tightening. The aim is to determine whether behaviour consistent with the balance sheet channel can be identified, although they admit that the endogeneity of the quantity of credit makes it difficult to come to any firm conclusions.

The problem of identification, that is, the fact that a relationship between credit and output does not necessarily imply the existence of a financial accelerator but

[6] Bernanke, Gertler and Gilchrist (1998) incorporate money and price stickiness in a dynamic general equilibrium model and allow for different types of borrowers to rationalise differential access to capital markets. They show that financial constraints amplify the effects of shocks to economic activity. Similar results are obtained by Cooley and Quadrini (2006), who find differential response of large and small firms to monetary policy shocks. Gallegati (2001) argues that the balance sheet channel propagates output fluctuations in response to a monetary policy shock by reducing the quantity (rather than by increasing the cost) of borrowing available to firms.

could be consistent with many theories led researchers to focus on firm level data and to use the sample splitting techniques common to the firm level investment literature discussed above. One strand of the literature focuses on inventory investment, given its important role in business cycle fluctuations. Kashyap, Lamont and Stein (1994), in their study of US manufacturing firms during the 1974-75 and 1981-82 recessions find evidence that inventory investment was constrained by cash flow for firms without access to public bond markets. Gertler and Gilchrist (1994) come to similar conclusions in their study of the differential effects of cash flow on inventory demand by small and large US firms between 1960 and 1991. Guariglia (1999) produces similar results for the UK (1968-91), finding that in recessions, firms with low coverage ratios or high debt ratios experience greater sensitivity of inventory investment to the coverage ratio in recessions and periods of tight monetary policy.

Similar work has also been done on investment in fixed assets. Bernanke, Gertler and Gilchrist (1996) investigate whether small firms are more sensitive to the economic cycle and indeed find evidence in favour of this. Gertler and Hubbard (1988) interact cash flow with a dummy for periods of recession to show that US manufacturing firms between 1970 and 1984 exhibited a higher sensitivity of investment to cash flow during recessions. Finally, Hu and Schiantarelli (1994) provide a novel methodological approach, an endogenous switching model, which obviates the need for *a priori* classification of firms into constrained and unconstrained. Again the recession in the US in 1982-83 is found to lead to greater cash flow effects on investment compared to other periods.

A paper in this vein which is of particular relevance to our concerns here is that of Oliner and Rudebusch (1996) who examine the sensitivity of investment to cash flow in periods of monetary tightening using quarterly data for a panel of US manufacturing firms over 1958-1992. They define monetary tightening using either Romer and Romer's (1989) dates constructed using the so-called narrative approach or the Federal Funds rate or the difference between the Federal Funds rate and a long-term bond rate. They estimate an investment equation including an interaction term between monetary policy and cash-flows and show that small firms display sensitivity of investment to cash flows after a monetary policy tightening; large firms do not appear to experience sensitivity to cash flow, either in general or in periods following monetary tightening. They interpret this as evidence of a balance sheet channel.

A final paper which is relevant for our paper is that of Bougheas *et al* (2003). They examine the effect of monetary tightening on firms' access to external sources of finance in the UK using a large panel of some 15000 UK firms over the 1990s. They find strong evidence that firm specific characteristics influence both the amount of bank finance relative to market finance as well as total firm debt. That the impact of these characteristics varies with the degree of monetary tightening is taken as evidence of a balance sheet channel in operation in the UK during the period examined.

3. Data description and construction

EXSTAT provides information on published annual company accounts along with various descriptive pieces of information on companies. It has the advantage that it can be merged with the London Share Price Dataset (LSPD), which provides stock exchange information on the quoted companies held in the EXSTAT database. Only UK manufacturing companies are selected. Additionally, we restrict our sample to firms with a minimum of five years of available data to ensure a reasonable span of data for each company. Information is available from 1970 to 1991[7]. The London Share Price Dataset (LSPD) has data on dividends, share prices and share capital. From our EXSTAT sample, we retain companies which have LSPD data. This effectively restricts our sample to 796 UK quoted companies.

We use information from both of these datasets in order to generate a large panel of companies with both accounting and stock market information. The EXSTAT data is largely annual although some companies produce two sets of accounts within 12 months or may have more than 12 months between accounts when they change their financial year[8]. The LSPD data is monthly for share prices and (usually) biannual for dividend data. When matching observations in these datasets, it is important to note that the end of the financial year differs between companies and can vary for any one company over time. To derive a single dividend payment for any year, we cumulate dividend payments between successive end financial years for each company.

[7] The data were taken from the 1992 EXSTAT tape. It has been used in other studies relating to the acquisition behaviour of firms (Dickerson, Gibson and Tsakalotos, 2002; 2003)
[8] Flow data are scaled accordingly when 12 month accounting periods are not used.

Similarly, a share price value for each company year is calculated from the average (end-month) share price for all months between successive end financial years.

Table 1 provides some summary statistics for the whole sample, as well as for firms classified by mean company size over the whole period and then divided into four quartiles (size is measured by deflated net assets). The distribution of observations in the four quartiles is approximately even. However, as the number of firms included in each quartile declines, the average number of years per company increases by quartiles.

The average size of a firm in the first quartile is about 100 times less than the average size of a firm in the fourth quartile. The differences are less pronounced when comparing median sizes, as means are influenced by extreme values. There is no clear pattern as to the evolution of sales growth and investment rates in different size classes. Moreover, there seems to be nothing particularly special about small companies (those in the first quartile) with the differences in the means of sales growth, investment rates, bank loans and retained earnings for small firms and the whole sample being statistically insignificant. By contrast the difference in average cash-flow and percentage of years with zero dividend payments between the first quartile and the whole sample are statistically significant, suggesting that small firms tend to hold less cash-flow and pay zero dividends more frequently than the average firm in the sample.

The variables of interest are gross investment, capital stock at replacement cost, average *Q* and cash-flow. Gross investment is constructed as the difference between the book value of property and other tangible assets in two consecutive periods. The sum of the two is gross investment. This is normalized by total assets at replacement cost averaged across periods *t-1* and *t*.

Total assets at replacement cost are calculated based on the perpetual inventory formula.

$$K_t^R = \pi_t K_{t-1}^R + (K_t^B - K_{t-1}^B)$$

where π_t is a deflator equal to $\pi_t = \frac{\left(1+\pi_t^F\right)}{(1+\delta)(1+\theta)}$, K^R denotes the replacement cost and K^B denotes the historical cost of assets. π_t^F is the gross fixed capital formation deflator, δ is the rate of depreciation and θ is the rate of technological progress, assumed to be 2% per year in the period under review. For the first period we use the capital stock at historical prices. For subsequent periods the recursive formula is used with constant depreciation rates of 2.5% for land and buildings and 8.19% for plant and machinery following King and Fullerton (1984) calculations for UK manufacturing.

Average *Q* is constructed using stock market data. For each period the stock market value of a firm is calculated as the average number of shares at the beginning of periods *t* and *t+1* multiplied by the average share price in period *t* available from the LSP database. The stock market value of the firm divided by total assets at replacement cost averaged over periods *t* and *t-1* is average Q.

Finally, the cash flow is given by the ratio of after-tax profits minus interest payments divided by the capital stock at replacement cost averaged over *t-1* to *t*.

Investment, average *Q* and cash flow are plotted in Figure 1. As can be seen, the three variables appear to move in line with each other. Although the pattern is not uniform, movements in *Q* and cash flow could be said to be leading movements in investment. Interestingly, in the period 1978-1982, a time of tight money followed by recession, a sharp decline in cash-flow appears to be associated with a decline in investment rates, despite the fact that *Q* remained stable in the beginning of that period and rose towards its end.

The monetary policy dummy capturing periods of policy tightness during which we expect financial constraints to be more binding is constructed in Angelopoulou (2005). This is a narrative indicator in the spirit of Romer and Romer (1989) based on a reading of all issues of the Quarterly Bulletin of the Bank of England between 1971 and 1992. The indicator identifies policy episodes based on four basic characteristics: a) there is a large increase in central bank rates; b) the adjustment to a higher level of interest rates is gradual and long-lasting; c) additional restrictive policy measures are taken; and d) there are statements by bank officials that the aim of the policy shift is to reduce inflationary pressures resulting from the domestic monetary situation or from exchange rate instability.

Based on the presence of these characteristics four periods are identified as policy episodes in the period under review[9]:

- June 1972-December 1973, when an increase of 8 percentage points of the Bank rate/Minimum Lending Rate occurred as a response to the existence of excess liquidity following the measures introduced in Competition and Credit Control.
- April to November 1976, when the Bank of England attempted to put an end to the sharp decline of the sterling exchange rate by increasing its intervention rate by 6 percentage points.
- November 1977 to November 1979, when key intervention rates increased by 12 percentage points in the most intensive period of policy tightening aiming at combating inflation.
- June 1988 to September 1990: A total increase of 7 percentage points was deemed necessary to prevent inflation from rising due to the overheating of the economy.

A monetary policy dummy is constructed which takes the value 1 in each month of a period of monetary policy tightening and the value 0 otherwise. To match annual firm-level data to this monthly dummy, observations are averaged across financial years and can therefore take values between 0 and 1 depending on the number of months between financial end-years which were characterized by monetary policy tightness.

4. Results and discussion

Tables 2-4 present the basic results. We estimate the augmented Q model using instrumental variables fixed effects estimator for two reasons. First, Q is clearly endogenous in that the investment strategy of a particular firm clearly influences both its market value and the replacement cost of its assets. Second, as the Hausman specification test suggests, we can reject a random effects model in favour of fixed effects. The fixed effects themselves are significant as the F tests in the tables show.

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[9] See Angelopoulou (2005).

Column (1) of Table 2 shows that a simple Q model performs well. An increase in Q causes investment to rise with the elasticity at the mean being 0.98 (a 10% rise in Q leads to a 9.8% rise in the investment rate). Adding cash flow (Table 2, column (2)) reduces the coefficient on Q slightly; cash flow, however, appears with the anticipated positive sign and is highly significant – a 10% increase in cash flow as a proportion of total assets (at replacement cost) at the mean raises investment by 1%. Finally, column (3) of Table 2 includes a composite variable to test whether the impact of cash flow varies with monetary conditions. We use lagged cash flow in periods of monetary tightness to incorporate the lags surrounding the effects of monetary policy. There is strong evidence that cash flow exerts more of an influence on investment in times of tight monetary policy. Whereas the elasticity of investment with respect to cash flow is 0.10 in general, it more than doubles during periods of monetary tightness (to 0.24).

In order to investigate whether these cash flow effects are the result of mismeasurement of Q or financial constraints, we split our sample using three criteria – size, dividend policy along with share issue activity and leverage. We allow the coefficients on all three explanatory variables (Q, cash flow and cash flow interacted with the monetary policy dummy) to vary depending on whether the firm (or firm year observation) is classified as financially constrained or not. These results are presented in Tables 3 and 4. On the assumption that small firms in our sample are more likely to be financially constrained, we classify firms into quartiles according to their mean size[10]. In the first column of Table 3, we define constrained firms as those in the first quartile of our size dummy. While cash flow remains significant for unconstrained firms, there is clear evidence that investment by small (constrained) firms is more sensitive to cash flow with the coefficient on cash flow for small firms being three times the size of that of non-small firms. This provides support for the hierarchy of finance theory and indicates the potential existence of a balance sheet channel in the transmission of monetary policy.

[10] This has the possible disadvantage that firms are assigned to a size class (small or not small) for their whole duration in the sample. An alternative method would be to allow firms to shift size classes. Hence we could classify firms on the basis of their size in each year relative to the 25th percentile for all companies through time. However, this leads to a reclassification of firms from constrained to unconstrained or vice versa even as a result of transitory changes in their size which is even less satisfactory.

A similar result is obtained when we use dividend payouts and share issues to identify constrained firms. Following Bond and Meghir (1994) and in line with the hierarchy of finance theory, we can divide firms into three categories (where D is dividends and N is new share issues:

D > 0 and N = 0	The firm finances investment from retentions, pays dividends and does not issue shares
D = 0 and N = 0	The firm is constrained, it pays zero dividends and does not raise external finance because of the cost
D = 0 and N > 0	The firm is constrained, it pays zero dividends and issues shares (which cost more)

We identify constrained company-years as occurring when dividends are zero irrespective of whether the company issues new shares or not. Companies with positive dividends in any year are classified as unconstrained. This classification has the advantage that companies can change category during the period and it places around 10% of the sample in the constrained category. The results are similar to those where constrained firms are identified on the basis of size. A 10% rise in cash flow in firms which are constrained raises the investment rate by 3.8%.

Finally, we split our sample on the basis of leverage (as suggested by the results of Bourgeas *et al*, 2006). Companies with high leverage ratios, defined as the sum of bank loans, overdrafts and short-term borrowings as a proportion of total assets, are expected to face greater financial constraints because they have a higher probability of default. In Table 3, we classify firms as constrained if their mean leverage ratio is greater than the 75th percentile across all firms. Thus firms are classified as either constrained or unconstrained for the duration of their presence in the sample as in the case of the sample split on the basis of size. The results provide further evidence in favour of financial constraints.

At times of tight monetary policy, we might expect that cash flow becomes a more important determinant of investment. Tight monetary policy reduces companies' cash flow thus directly influencing investment; at the same time, net worth also declines, making it more costly or difficult to raise external finance. It is often argued that it is firms without access to public debt markets (such as the commercial paper market) which are more affected by periods of monetary tightness (Kashyap, Lamont and Stein, 1994). In the period under consideration here, companies' recourse to public debt markets was extremely limited in the UK (Davis, 2001), suggesting that alternative cheap sources of finance at times of monetary tightening were not readily available. Oliner and Rudebusch (1996) examine the hypothesis that it is only for smaller firms that investment is sensitive to cash flow in times of monetary tightness. Effectively, they interact a monetary policy dummy with cash flow and test this specification for small and large companies. Their results confirm the hypothesis: investment by small firms has a higher sensitivity to cash flow in times of monetary tightness compared to other times whereas this is not true for large firms.

This suggests that we distinguish between the cash flow effects for constrained and unconstrained firms according to different degrees of monetary tightness. Thus each of the equations in Table 3 includes the results of including the monetary policy tightness dummy interacted with cash flow in both constrained and unconstrained firms. The results suggest that constrained firms do indeed exhibit a higher sensitivity to cash flow during periods of monetary tightness and χ^2 tests for equality of the coefficients are presented at the bottom of the Table. These indicate that the effect of cash flow on investment in periods of monetary tightness is significantly higher (at least at the 10% level of significance) for constrained than for unconstrained firms (in the case where the sample is split according to size, the difference is significant only if we include two lags of the cash flow variable interacted with monetary tightness).

Table 4 presents the investment elasticities for constrained and unconstrained firms. The cash flow elasticities in general are higher in constrained firms compared to unconstrained ones by a factor of around 3. This is true however the sample is split. Similarly strong results are evident for cash flow effects in periods of monetary tightness: the constrained firms have a higher investment elasticity than the unconstrained firms and monetary tightness causes the elasticity of investment with respect to cash flow for constrained firms to increase.

Table 5 presents some robustness results. First, we modify our use of dividends and share issue policy to classify firms. Column (1a) classifies a firm as constrained either if over the financial year it did not distribute dividends and it issued no shares or it issued shares (irrespective of its dividends). Firms which issues shares are considered constrained since according to the hierarchy of finance theory, the cost of raising external finance through share issues is greater than relying on internally generated funds. In Column (1b) we expand the classification used in column (1a) to include firms which have cut their dividends in a particular financial year. The rationale for the inclusion of company years characterized by a cut in dividends stems from the possible signaling role that dividends can play which makes firms reluctant to cut them (Bhattacharya, 1979). Whilst it is still the case that financially constrained firms have higher cash flow sensitivities both compared to unconstrained firms and in periods of monetary tightness (with the exception of column 1b), the results are no longer significant.

This is in contrast to the results in column (2) which suggest that a change in the classification using leverage actually strengthens the results compared to those presented in Table 3. In Table 5 we allow firms to move between being constrained and unconstrained on the basis of leverage across time. Thus we define constrained firms as those with a leverage ratio greater than the 75th percentile (where the percentiles are calculated across the whole sample). Our results are robust to this redefinition.

A final robustness check involves examining the impact of the effect of acquisitions on the results. Fazzari, Hubbard and Petersen (1987) do not include acquirers in their sample, something which is also true of some subsequent papers. The rationale is that acquisitions can create discontinuities in the data. More importantly, the cash-flow sensitivity of firms which acquire may be biased upwards because acquisitions represent fairly large investments and at least some internal funds are likely to be necessary to fund them. Furthermore, Jensen's (1986) free cash flow theory was motivated by a desire to explain the then recent acquisition wave. Our sample includes acquirers but columns (3a) and (3b) of Table 5 suggest that the exclusion of years where acquisitions occurred does not change the conclusions of the previous analysis (column (3a) presents the results from splitting the sample on the basis of size and column (3b) on the basis of zero dividends).

5. Conclusions

This paper has sought to provide a preliminary examination of the relevant of the balance sheet channel for monetary policy in the UK using firm level data. The results suggest that investment by firms that are likely to face greater financial constraints (either because they are small, or as revealed by their financial policy or on the basis of leverage) is indeed more sensitive to cash flow. The results are fairly robust to alternative classifications of constrained/unconstrained firms.

The implications of these findings are that, at least for the period under consideration here, financial accelerator effects were a determining characteristic of UK business cycles. At the same time, however, monetary policy was more effective at influencing the cycle since it operated not only via traditional channels such as the interest rate or exchange rate, but also through its effect on firms' net worth and hence spending decisions.

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Table 1: The profile of the sample

	Size class				
	1 All	2 25th percentile	3 50th percentile	4 75th percentile	5 100th percentile
General characteristics					
Number of companies	783	225	204	187	167
Number of observations	11190	2805	2791	2807	2787
Average number of years/company	14.3	12.5	13.7	15	16.7
Average size (deflated net assets)	£268 million	£9.3 million	£25.8 million	£62.7 million	£908 million
Median size	£37 million	£8.3 million	£25 million	£60.2 million	£350 million
Average nominal sales growth *per annum*	17.6%	17.9%	16%	18.2%	18.3%
Average investment rate (gross investment/total assets at replacement cost)	5.8%	5.8 %	5.6%	6.1%	5.8%
Finance					
Leverage	8.5%	8.3%	9%	8.8%	7.8%
Retained earnings (% of available profits)	39.4%	32%	43.2%	35.6%	46.8%
Cash flow (% total assets at replacement cost)	3.5%	3.1%	4.1%	3.7%	3.3%
Percentage of years with zero gross dividend payout	9.4%	18%	8.7%	6.6%	4.2%

Table 2: The *Q* model and the extended *Q* model			
Regression of Gross investment in tangibles on:	(1)	(2)	(3)
Constant	0.0025 (0.0046)	0.0012 (0.0045)	-0.0006 (0.0045)
Q	0.0863 (0.0067)	0.0793 (0.0071)	0.0776 (0.0070)
Cash flow		0.1730 (0.0240)	0.1605 (0.0242)
Cash flow * dummy indicating monetary policy tightness			0.2414 (0.0438)
No. of observations	8018	8008	8005
No. of companies	783	783	783
Wald test	χ^2 (1)=2213 prob > χ^2 =0.00	χ^2 (2)=2426 prob > χ^2 =0.00	χ^2 (3)=2458 prob > χ^2 =0.00
F-test individual effects	F(782,7234)= 1.91 prob > F =0.00	F(782,7223)= 1.96 prob > F =0.00	F(782,7219)= 1.97 prob > F =0.00
Hausman specification test	χ^2(1) = 60.61 prob > χ^2 =0.00	χ^2(2) = 95.05 prob > χ^2 =0.00	χ^2(3) = 104.31 prob > χ^2 =0.00

Q is the average market value of the firm divided by the average replacement cost of assets; Cash flow is profit before tax minus tax and interest payments divided by average replacement cost of assets. Prob is probability.
Estimation is by instrumental variables where instruments used include lags of Q and cash flow.

Table 3: Cash flow and monetary policy tightness effects in constrained and unconstrained firms

Regression of Gross investment in tangibles on:	Sample split on: (1) Size (1a)	(1b)	(2) Dividend Policy	(3) Leverage
Constant	0.1465 (0.0705)	0.1463 (0.0706)	0.1419 (0.0696)	0.1546 (0.0686)
Q in constrained firms	0.1235 (0.0196)	0.1249 (0.0199)	0.1988 (0.0269)	0.0939 (0.0288)
Q in unconstrained firms	0.0497 (0.0086)	0.0489 (0.0086)	0.0455 (0.0117)	0.0763 (0.0084)
Cash flow in constrained firms	0.4534 (0.0475)	0.4550 (0.0476)	0.6181 (0.0607)	0.4522 (0.0499)
Cash flow in unconstrained firms	0.1275 (0.0293)	0.1273 (0.0293)	0.1448 (0.0291)	0.0849 (0.0277)
Cash flow in periods of monetary tightness in constrained firms (lagged 1 period)	0.2573 (0.0839)	0.1954 (0.0858) 0.3118 (0.1080)	0.8340 (0.1758)	0.2948 (0.1024)
Cash flow in periods of monetary tightness in unconstrained firms (lagged 1 period)	0.1443 (0.0724)	0.1286 (0.0744) 0.1122 (0.0794)	0.1513 (0.0643)	0.0996 (0.0650)
No. of observations	8005	8002	8005	8005
No. of companies	783	783	783	783
Wald test	χ^2 (23)=2419 prob > χ^2 =0.00	χ^2 (25)=2417 prob > χ^2 =0.00	χ^2 (23)=2511 prob > χ^2 =0.00	χ^2 (23)=2584 prob > χ^2 =0.00
F-test individual effects	F(782,7199)= 1.74 prob > F =0.00	F(782,7194)= 1.73 prob > F =0.00	F(782,7199)= 1.81 prob > F =0.00	F(782,7199)= 1.86 prob > F =0.00
Significance of year dummies	χ^2 (17)=72.04 prob > χ^2 =0.00	χ^2 (17)=66.62 prob > χ^2 =0.00	X^2 (17)=98.21 prob > χ^2 =0.00	χ^2 (17)=85.68 prob > χ^2 =0.00
Hausman specification test	χ^2(23) = 98.43 prob > χ^2 =0.00	χ^2(25) = 100.20 prob > χ^2 =0.00	X^2(23) = 115.52 prob > χ^2 =0.00	χ^2(23) = 105.02 prob > χ^2 =0.00
χ^2 tests of equality of coefficients on:				
Q	χ^2 (1)=16.48 prob > χ^2 =0.00	χ^2 (1)=16.83 prob > χ^2 =0.00	χ^2 (1)=25.94 prob > χ^2 =0.00	χ^2 (1)=0.45 prob > χ^2 =0.50
Cash flow	χ^2 (1)=34.26 prob > χ^2 =0.00	χ^2 (1)=34.55 prob > χ^2 =0.00	χ^2 (1)=58.09 prob > χ^2 =0.00	χ^2 (1)=40.76 prob > χ^2 =0.00
Cash flow * monetary tightness dummy	χ^2 (1)=1.26 prob > χ^2 =0.26	χ^2 (1)=3.54 prob > χ^2 =0.06	χ^2 (1)=13.42 prob > χ^2 =0.00	χ^2 (1)=3.07 prob > χ^2 =0.08

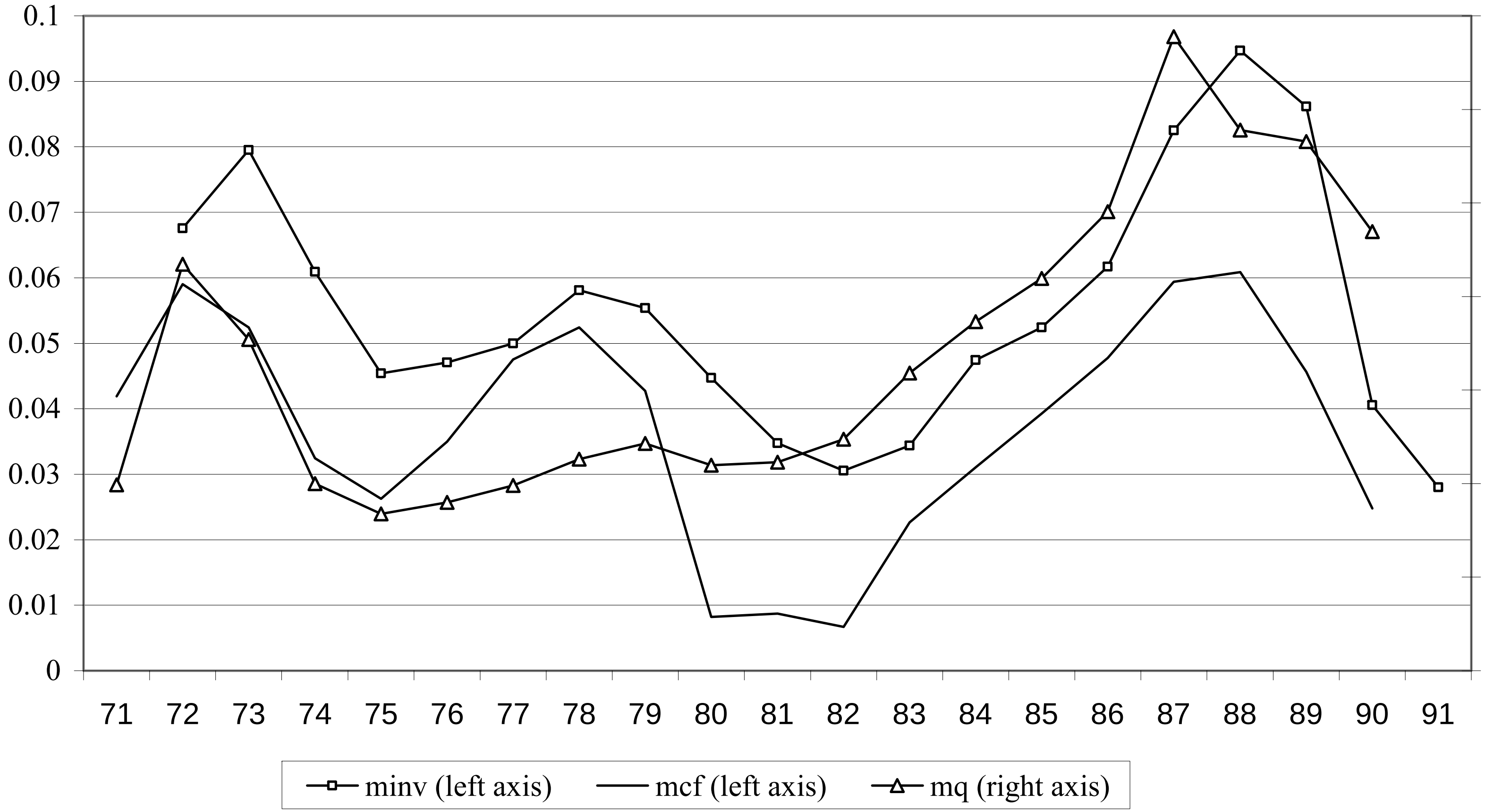
Notes: Q and CF are defined as above. The size dummy takes the value 1 if a firm's average size is below the 25^{th} percentile. The dividend policy dummy takes a value 1 if the firm paid zero dividends. Leverage is defined as bank loans and overdrafts plus short-term debt over total assets and takes the value 1 if a firm's average leverage is below the 25^{th} percentile. In column 1(b) cash flow in periods of monetary tightness is lagged 1 and 2 periods.

Table 4: Elasticities based on results in Table 4				
	Sample split on:			
	(1) Size		(2) Dividend Policy	(3) Leverage
	(1a)	(1b)		
Q in constrained firms	1.40	1.42	2.26	1.07
Q in unconstrained firms	0.56	0.56	0.52	0.87
Cash flow in constrained firms	0.28	0.28	0.38	0.28
Cash flow in unconstrained firms	0.08	0.08	0.09	0.05
Cash flow in periods of monetary tightness in constrained firms	0.43	0.59	0.88	0.45
Cash flow in periods of monetary tightness in unconstrained firms	0.17	0.22	0.18	0.11

Table 5: Cash flow and monetary policy tightness effects in constrained and unconstrained firms: sensitivity tests

Regression of Gross investment in tangibles on:	Sensitivity test: (1) Dividend Policy (1a)	(1b)	(2) Leverage	(3) without acquisitions (3a)	3(b)
Constant	0.1629 (0.0710)	0.1662 (0.0669)	0.1726 (0.0756)	0.1513 (0.0659)	0.1503 (0.0646)
Q in constrained firms	0.0273 (0.0718)	0.0616 (0.0101)	0.0114 (0.0216)	0.0995 (0.0182)	0.1278 (0.0235)
Q in unconstrained firms	0.1005 (0.0266)	0.0813 (0.0178)	0.1300 (0.0190)	0.0375 (0.0080)	0.0435 (0.0109)
Cash flow in constrained firms	0.7358 (0.2895)	0.4417 (0.0636)	0.5704 (0.0698)	0.4581 (0.0445)	0.5737 (0.0567)
Cash flow in unconstrained firms	0.0038 (0.0860)	0.0097 (0.0708)	-0.1007 (0.0617)	0.1370 (0.0275)	0.1406 (0.0270)
Cash flow in periods of monetary tightness in constrained firms (lagged 1 period)	0.1981 (0.2603)	0.1249 (0.0879)	0.3794 (0.1269)	0.2091 (0.0803)	0.7416 (0.1612)
				0.2766 (0.1009)	0.3520 (0.2225)
Cash flow in periods of monetary tightness in unconstrained firms (lagged 1 period)	0.0815 (0.0734)	0.1355 (0.0704)	0.0546 (0.0705)	0.1533 (0.0700)	0.1129 (0.0617)
				0.0997 (0.0747)	0.1364 (0.0660)
No. of observations	8005	8005	8005	7824	7824
No. of companies	783	783	783	783	783
χ^2 tests of equality of coefficients on:					
Q	χ^2 (1)=0.59 prob > χ^2 =0.44	χ^2 (1)=1.12 prob > χ^2 =0.29	χ^2 (1)=12.34 prob > χ^2 =0.00	χ^2 (1)=13.14 prob > χ^2 =0.00	χ^2 (1)=9.97 prob > χ^2 =0.00
Cash flow	χ^2 (1)=3.91 prob > χ^2 =0.05	χ^2 (1)=12.0 prob > χ^2 =0.00	χ^2 (1)=33.80 prob > χ^2 =0.00	X^2 (1)=37.90 prob > χ^2 =0.00	χ^2 (1)=56.05 prob > χ^2 =0.00
Cash flow * monetary tightness dummy	χ^2 (1)=0.25 prob > χ^2 =0.62	χ^2 (1)=0.01 prob > χ^2 =0.90	χ^2 (1)=5.62 prob > χ^2 =0.02	χ^2 (1)=3.10 prob > χ^2 =0.08	χ^2 (1)=9.06 prob > χ^2 =0.00

Figure 1: Mean investment (minv), Q (mq) and cash-flow (mcf), by year



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